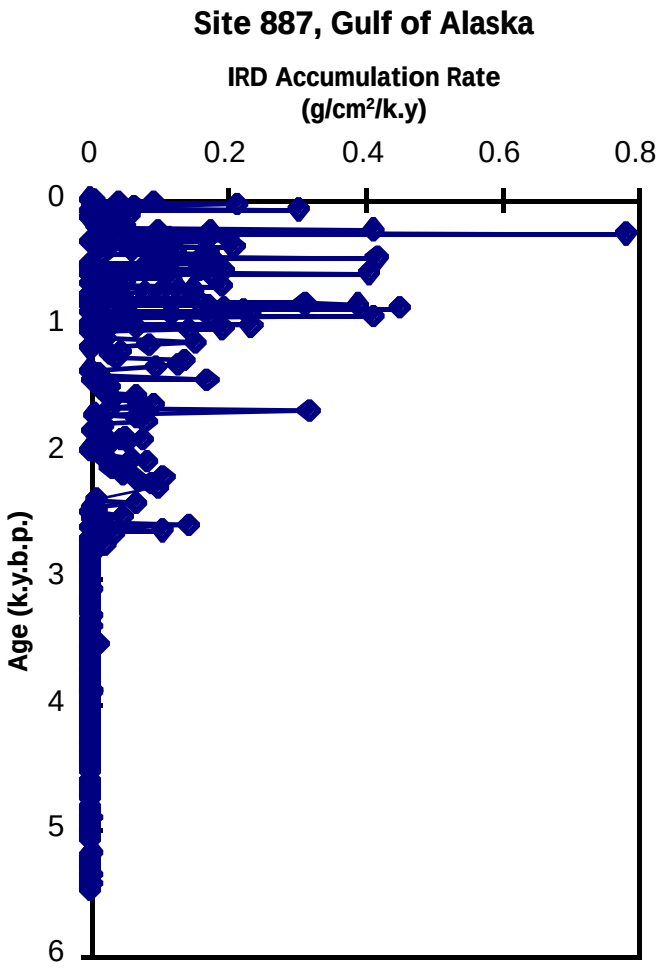
Ice-rafted debris and Northern Hemisphere glaciation history

Lawrence A. Krissek, Department of Geological Sciences, The Ohio State University, Columbus, and
Kristen E. Kudless, Department of Geological Sciences, The Ohio State University, Columbus

The transport of land-derived sediment by icebergs, and the release of that sediment during iceberg melting, is widely accepted as the primary mechanism for supplying anomalously large (sand-sized and larger) land-derived grains to marine settings away from a continental margin and at mid to high latitudes. The temporal distribution of this material (termed "ice-rafted debris" or IRD) can be interpreted as a history of glacial extension to sea level, whereas the geographic distribution and the composition of the IRD can be used to identify the glaciated source areas. As a result, the study of IRD in stratigraphically intact deep marine sedimentary sequences often provides a more complete record of continental glaciation than the study of thin, discontinuous deposits on the formerly glaciated continent.



Our efforts have focused on deciphering the glacial history of the Northern Hemisphere, with the specific goals of: 1) identifying the onset of Northern Hemisphere glaciation, 2) documenting the timing of glacial intensification in the Late Pliocene, and 3) interpreting regional glacial histories during the past 2.6 million years. In both the North Pacific (DSDP Leg 86 and ODP Leg 145 cores — see figure for an example) and the Norwegian-Greenland Sea (ODP Legs 104 and 152 cores), IRD is observed in sediments as old as 5.0 - 6.6 million years old, indicating the presence and expansion of alpine glaciers to sea level by that time. These onset ages are consistent with limited data from onshore exposures in these areas, and indicate that Northern Hemisphere glaciation began, at least locally, well before 2.6 million years ago (once the widely accepted time of glacial initiation).

IRD records in both the North Pacific and the Norwegian-Greenland Sea consistently indicate a significant increase in glacial activity at approximately 2.6 million years ago (see figure), when continent-scale glaciation began in the Northern Hemisphere. IRD records in both areas also exhibit a significant change in the pattern (amount and/or frequency) of IRD supply at approximately 0.7 - 1.0 million years ago, suggesting a major shift in the pattern of glacial/interglacial cycles at this time. Both of these changes are consistent with features observed in other records of Northern Hemisphere paleoclimates.

During the past one million years, temporal variations in the input of IRD to both the North Pacific and the Norwegian-Greenland Sea have not responded directly to changes in global ice volume, as interpreted from oxygen isotope ratios in foraminifera. Instead, some peaks in IRD input have occurred during global ice maxima, some peaks have occurred during global ice minima, and some peaks have occurred during transitions between the ice volume extremes. The complexity of these signals suggests that each IRD source has a distinct history; our future efforts will focus on deciphering the nature and causes of these regionally unique histories.